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# Adult Salmon Runs and Streamflow Data at a Resistance Board Weir on Beaver Creek, Alaska, 1998-2000

Nathan Collin, Lon Kelly and Jon Kostohrys

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## Cover Photo

Beaver Creek weir and trap, 2000. BLM photo.

## Authors

Nathan Collin left his position as fisheries technician with BLM's Northern Field Office in Fairbanks, Alaska in 2000. He now lives in Ranchita, California. Lon Kelly is a recreation planner and Jon Kostohrys is a hydrologist, both on the White Mountains National Recreation Area Team at the BLM's Northern Field Office in Fairbanks, Alaska.

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## Abstract

From July 6 to July 7, 1998, July 9 to August 8, 1999, and July 3 to August 14, 2000, a resistance board weir was operated on Beaver Creek, a tributary to the Yukon River. In 1998 high water washed out the weir trap within 18 hours of its installation, and as a result no data were collected. In 1999, 75 summer chum salmon (*Oncorhynchus keta*) and 128 chinook salmon (*Onchorhynchus tshawytscha*) were counted through the weir. In 2000, 11 summer chum salmon and 114 chinook salmon were counted through the weir. In all years when data were collected there was a disparity between numbers of male and female fish, with males outnumbering females. Mean monthly discharges in Beaver Creek ranged from 22 cms in June 1999 to 98 cms in August 1998. Monthly discharges were generally above the 13-year mean in 1998 and 2000, and below the 13-year mean in 1999. Salmon counts were highest in July following daily discharges that exceeded the mean.

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# 1 Introduction

In 1996 and 1997, the Bureau of Land Management operated a resistance board weir on Beaver Creek in Alaska. These were the first two years of a five-year study designed to count salmon using the middle to upper reaches of the Beaver Creek component of the National Wild and Scenic Rivers System, located in the White Mountains National Recreation Area. This work, along with additional background information, is described in a BLM open file report (Collin and Kostohrys, 1998).

In this paper, we document the data collected in the final three years of the project: 1998, 1999 and 2000. During these years we determined the length and sex of each salmon passing through the weir trap. In 2000 we also attempted to determine the age of the salmon we processed by collecting scale samples. We monitored hydrologic conditions at the weir site each year.

The project ended in 2001, when the only work at the site consisted of removing the weir and project camp from the field.

The objectives of the project were these:

- Describe the timing and strength of summer salmon runs in upper Beaver Creek.
- Describe the composition of salmon spawning aggregates using upper Beaver Creek.
- Monitor hydrologic conditions at the weir site.

# 2 Study Area

The upper Beaver Creek watershed, located in the eastern interior of Alaska, is part of Yukon-Tanana upland (Wahrhaftig, 1965). This area is characterized by forested upland plateaus, some of gentle relief but others topped by steep, 1,000 to 1,600 m tundra-covered mountains. Beaver Creek, like its tributaries, is narrow and steep in the headwaters, but widens downstream as the gradient decreases, increasing in meander to form sloughs and extensive, marshy lowlands. The relatively flat floodplain, often underlain by discontinuous permafrost, ranges from 1 to 5 km wide. Numerous springs occur in the basin that contribute significantly to winter streamflow.

Beaver Creek National Wild River originates at the confluence of Bear and Champion Creeks, about 80 km north of Fairbanks, Alaska. It flows 180 km through the 445,000-hectare White Mountains National Recreation Area and then an additional 300 km through the Yukon Flats National Wildlife Refuge, where it meets the Yukon River. The weir site is approximately 325 km upriver from the mouth of Beaver Creek (Figure 1). This section of the river is wide and straight, and the substrate consists primarily of coarse gravel (2.5 cm - 7.62 cm), small cobble (7.62 cm - 15.2 cm), and large cobble (15.2 cm - 30.5 cm). This substrate is typical of Beaver Creek from Victoria Creek upriver to the headwaters.

Fish species found in Beaver Creek include Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cylindraceum*), northern pike (*Esox lucius*), burbot (*Lota lota*), sheefish (*Stenodus leucichthys*), longnose sucker (*Catostomus catostomus*), slimy sculpin (*Cottus cognatus*), chum salmon (*Oncorhynchus keta*), and chinook salmon (*Onchorhynchus tshawytscha*). Arctic grayling is the species most sought after by sport fishers (BLM, 1983).

# 3 Material and Methods

## 3.1 Weir construction and installation

The materials, construction methods, and installation of the weir are generally described by Collin and Kostohrys (1998). In 1999 picket panels were added between the trap and the bank to move the trap out into the stream to maintain adequate depth at low flows. The weir installation is shown in Figure 2.

The weir was operated in the same manner as in 1996 and 1997 (Collin and Kostohrys, 1998). Visual inspections for holes and structural problems were conducted daily. Fish carcasses and debris were cleaned from the weir as they accumulated. Cleaning typically involved walking on the weir panels until they were partially submerged to allow the current to flush the debris off. At times it was necessary to remove debris fouling the weir by hand.

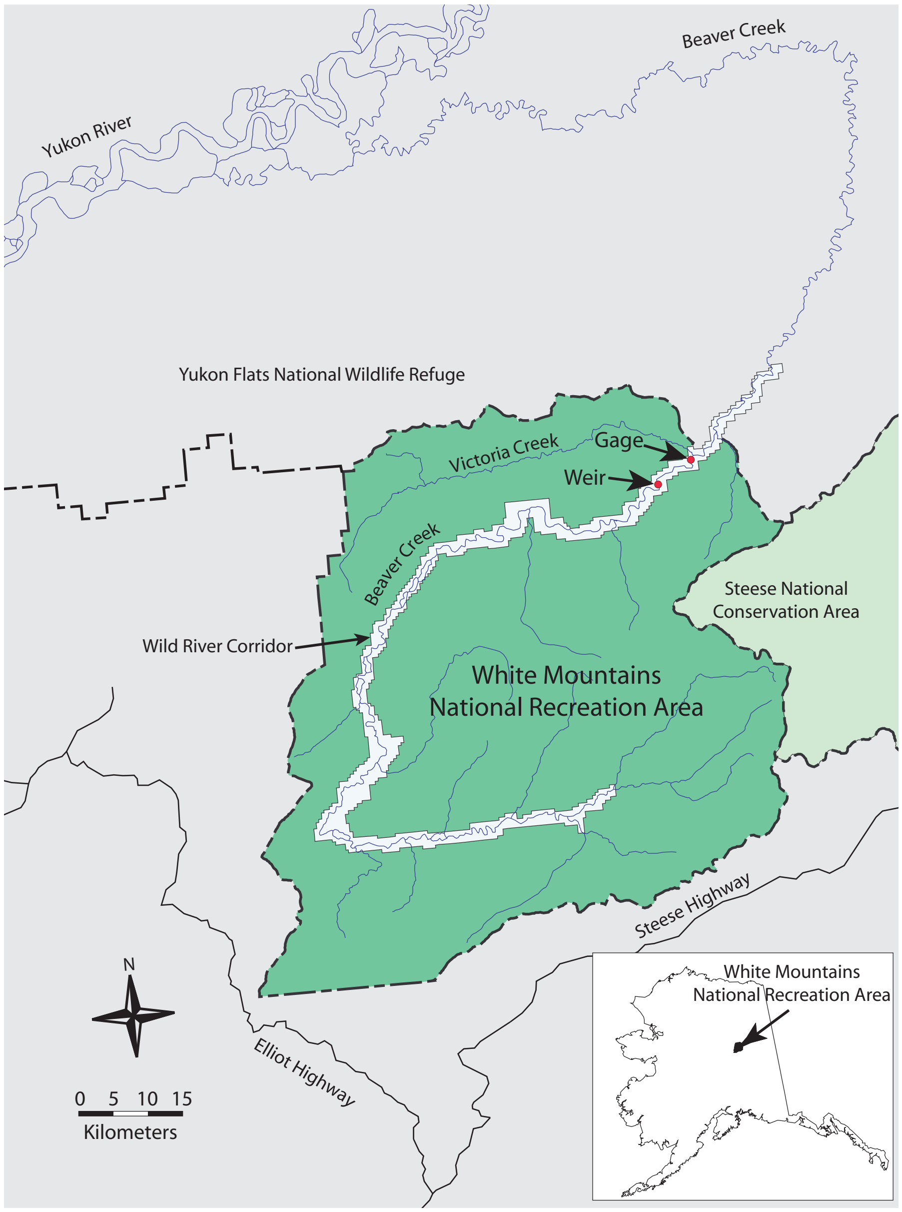


FIGURE 1 Location map.

FIGURE 2 Installed weir and trap.

## 3.2 Salmon

Salmon data were collected in 1999 and 2000. In 1999 all salmon data were collected by one of us (Collin). In 2000, rotating teams of two staff members worked at the site in ten-day shifts.

During its operation the weir was monitored at least every six hours—more often around the peak of the migration. When fish were present in the trap a staff member entered the trap, and processed the fish one at a time. Fish were classified by species and sex and fork lengths were measured to the nearest millimeter in a padded aluminum cradle.

Data were called by in Motorola satellite phone to the Alaska Department of Fish and Game for use in escapement estimates.

In 2000 scales were taken from chinook and chum salmon to provide data on age classes. Scales were sampled following Alaska Department of Fish and Game protocol for the preferred area on the fish. Scales were placed in labeled coin envelopes, one envelope per fish. Scales were pressed at the Northern Field Office on a Carver Model 3912 press at 66 C at 6.8 t for 30 s. The Alaska Department of Fish and Game Commercial Fisheries Division read the scales and determined age for chinook salmon.

After a fish was processed, it was carried upstream of the weir, where it was supported by hand and allowed to recover in relatively slow current prior to release.

## 3.3 Hydrology

A staff gage was installed each year to measure water levels. The gage was surveyed to reference elevation (bench) marks, significant high-water marks, and the current water level. The datum of the water level readings was adjusted so that the water level reading corresponded to the deepest depth of the river at the weir. Cross-sectional discharge (streamflow) measurements were made using a Price AA current meter to measure water velocity, and a topsetting wading rod and tag line were used for depth and width.

The staff gage readings were then used as the independent variable to compute discharge. A water level versus discharge rating was developed by combining the direct discharge measurements and computer-simulated peak flows using log-log regression statistics (Rantz et al., 1982). A single water level versus discharge rating was developed using discharge measurements for all three years. Differences from the actual measurements to the values calculated using the single log-log regression equation were kept within about five percent using the shifting control method (Rantz et al., 1982). Data were then compared to the automated water-level recorder data that have been collected from 1988 to 2000 at a site about 9 km downstream of the weir, just upstream of Victoria Creek (Kostohrys et al., In preparation).

# 4 Results

## 4.1 Weir performance

In 1998 the weir was installed on July 6. The water level rose rapidly and the trap washed downstream on July 7. No salmon data were collected in 1998. The high water continued throughout the summer and the weir was allowed to freeze into the winter ice.

In the spring of 1999, all weir panels were removed. The old trap was recovered, in pieces, from several pools downstream. The weir had sustained damage to many pickets and resistance boards during flooding, freezing in, and breakup. Approximately one-fifth of the pickets were repaired or replaced on site. The refurbished panels were then installed on the original cable with a replacement trap. During 1999 the weir was operational from July 9 to August 8. Counting ceased on August 8 due to rapidly rising water.

In 2000 the weir was operational from July 3 to August 14. High water submerged the weir panels and washed the trap downstream on August 14, marking the end of data collection for the project. The high water persisted into October, when it was finally possible to remove the weir.

The weir was removed from the field in 2001. At that time many of the pickets had become brittle, probably due to exposure to sunlight and extreme temperatures. The panels were disassembled, destroying the pickets in the process. With the exception of the pickets, the weir components were salvaged.

## 4.2 Salmon

***1999***

A total of 128 chinook salmon passed through the weir in 1999. Chinook salmon daily counts were relatively concentrated around the peak of the migration, which occurred on July 27, trailing off until the last day of data collection (Figure 3). Males outnumbered females throughout the period. Fork length of chinook salmon ranged from 525 mm to 1018 mm. Figure 4 provides length-frequency histograms for the salmon passing through the weir in 2000.

A total of 75 summer chum salmon passed through the weir in 1999. Chum salmon daily counts showed a gradual increasing trend prior to July 8, and then continued with no clear declining trend, as shown in Figure 3. Fork length of sampled chum salmon ranged from 549 mm to 720 mm.

In 1999 the ratio of male to female chinook salmon counted was 11:1. The ratio for chum salmon was 4:1.

***2000***

A total of 114 chinook salmon were counted in 2000. The peak of the migration for chinook salmon occurred July 23 and then daily counts declined quickly (Figure 3). The marked disparity between male and female numbers observed in 1999 persisted. Fourteen female chinook salmon passed through the weir in 2000.

Figure 5 provides length-frequency histograms for the chinook salmon passing through the weir in 2000. Two chinook salmon that had been marked with blue spaghetti tags by the Alaska Department of Fish and Game near the mouth of the Yukon passed through the weir.

A total of 11 chum salmon were counted through the weir in 2000. Chum salmon never showed a peak (Figure 3). Chum salmon continued to appear at the weir through the end of the period, one or two at a time.

The ratio of male to female chinook salmon counted in 2000 was 7:1. The ratio for chum salmon was 10:1.

Of the 114 chinook salmon processed in 2000, 65 scale samples were read to determine the age of the fish (Table 1). Scales from 13 of the 14 female chinook salmon could be read, as opposed to 52 of

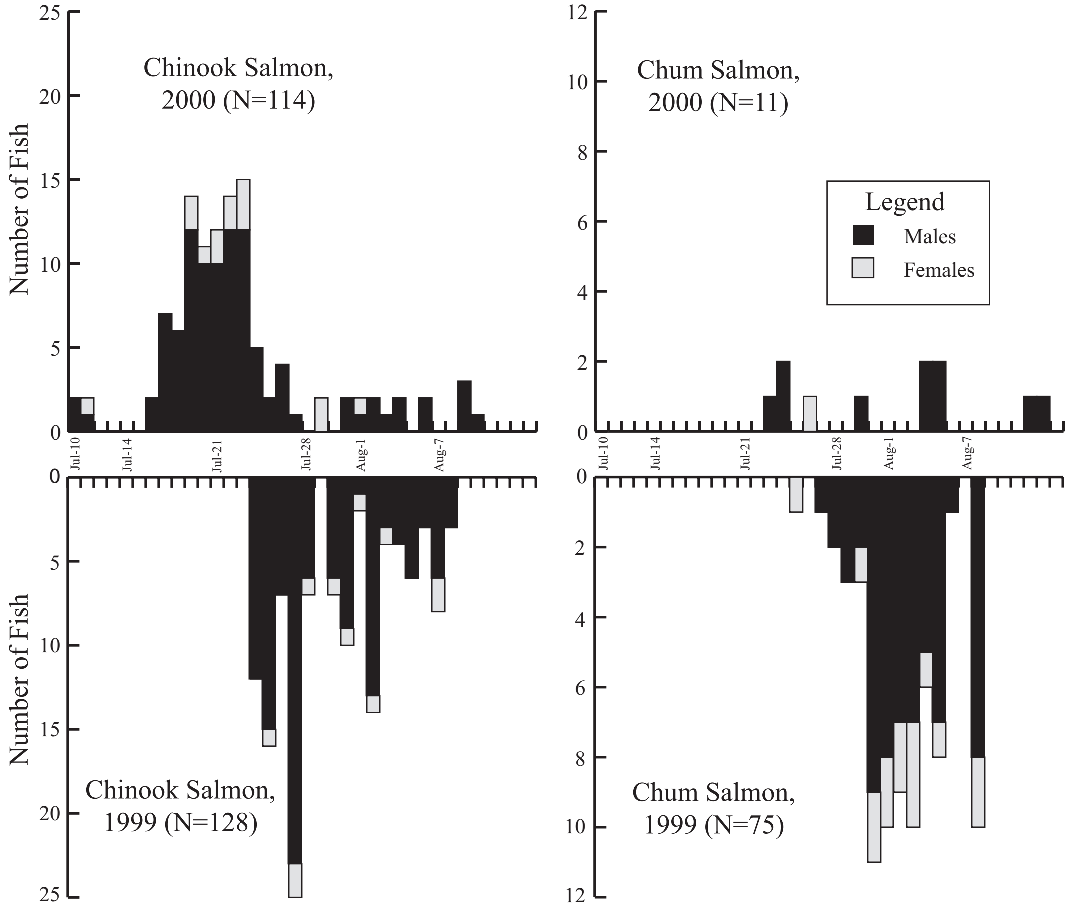


FIGURE 3 Daily counts of summer chum and chinook salmon passing through the Beaver Creek weir, 1999 and 2000. Weir operated from July 9 to August 8, 1999, and July 8 to August 14, 2000.

the 100 male chinook salmon. Of the 49 scale samples that could not be aged, 38 were identified as "not pressed" or "bad press" by the press operator, and these were not passed on to the Alaska Department of Fish and Game. The ratio of ages read to samples taken (65:114) is atypically low for studies of this type in Alaska (Price, 2002). Most of the scales that were not pressed, or were not pressed satisfactorily, were moldy or severely curled when removed from the envelopes. None of the 11 chum salmon scale samples were aged because the samples were lost after they were delivered from the field.

Female chinook salmon in the sample of 65 aged fish were older and longer for any given age than male chinook salmon in the sample.

### 4.3 Hydrology

Monthly discharge is compared in Table 2. Water levels and daily discharges are plotted in Figure 6. Mean daily discharge for 1998, 1999, and 2000 is tabulated in Appendix B.

## 5 Discussion

### 5.1 Weir siting and performance

Weir performance was consistent with that observed in the first two years of the project (Collin

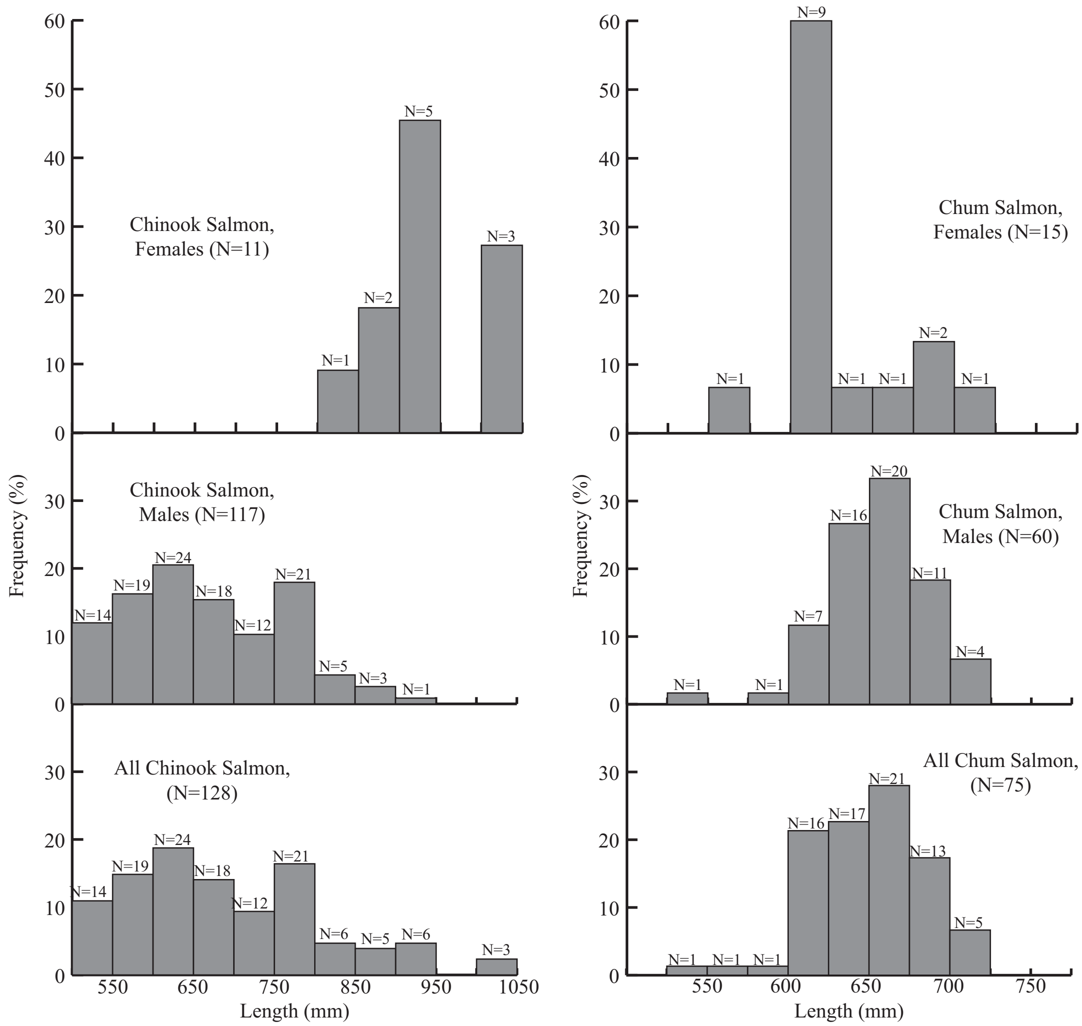


FIGURE 4 Length-frequency histograms for chinook and chum salmon at the weir, 1999.

TABLE 1 Chinook salmon escapement and mean length (mm) by sex and age, Beaver Creek, 2000.

| | | Age (all sampled fish spent one year in fresh water) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 3 | | 4 | | 5 | | 6 | |
| | | No. | % | No. | % | No. | % | No. | % |
| Male | N=52 | 5 | 7.7 | 37 | 56.9 | 10 | 15.4 | 0 | 0.0 |
| Female | N=13 | 0 | 0.0 | 4 | 6.2 | 8 | 12.3 | 1 | 1.5 |
| All | N=65 | 5 | 7.7 | 41 | 63.1 | 18 | 27.7 | 1 | 1.5 |
| Male | Mean Length | 602.0 | | 773.9 | | 816.4 | | no data | |
| | Std. Error | 25.9 | | 59.7 | | 58.5 | | no data | |
| Female | Mean Length | no data | | 871.3 | | 892.5 | | 835.0 | |
| | Std. Error | no data | | 47.7 | | 48.7 | | 0.0 | |

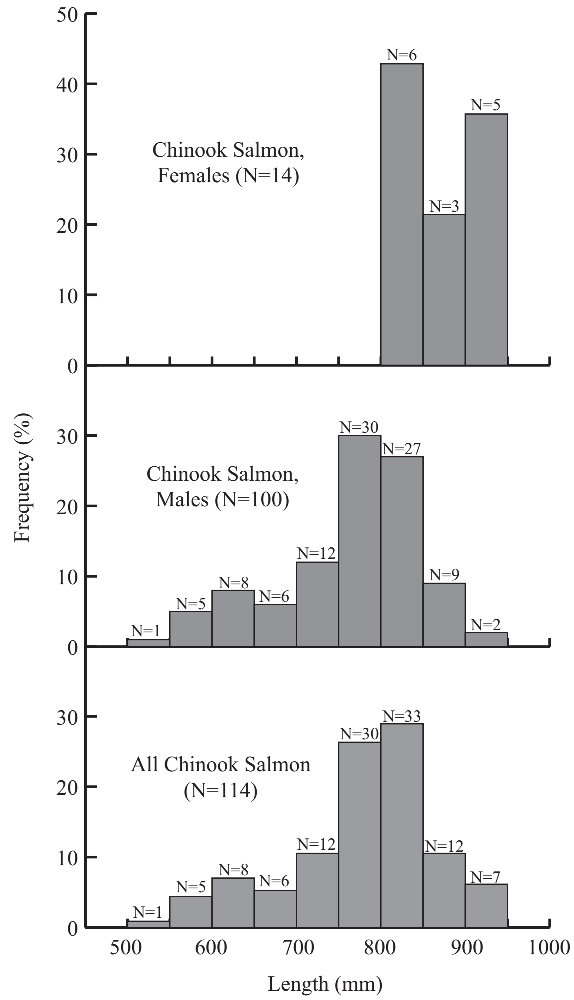


FIGURE 5  Length-frequency histograms for chinook salmon at the weir, 2000.

TABLE 2  Comparative mean monthly discharge for Beaver Creek.

| | June | | July | | August | |
|---|---|---|---|---|---|---|
| | $m^3/sec$ | % of 13-year mean | $m^3/sec$ | % of 13-year mean | $m^3/sec$ | % of 13-year mean |
| 13-year Mean[a] | 62 | 100% | 31 | 100% | 56 | 100% |
| 1998 | 31 | 51% | 70 | 223% | 90 | 160% |
| 1999 | 22 | 36% | 24 | 75% | 48 | 87% |
| 2000 | 87 | 141% | 29 | 91% | 80 | 144% |

[a]From stream gage data at site 9 km downstream, Beaver Creek above Victoria Creek (Kostohrys et al., In preparation)

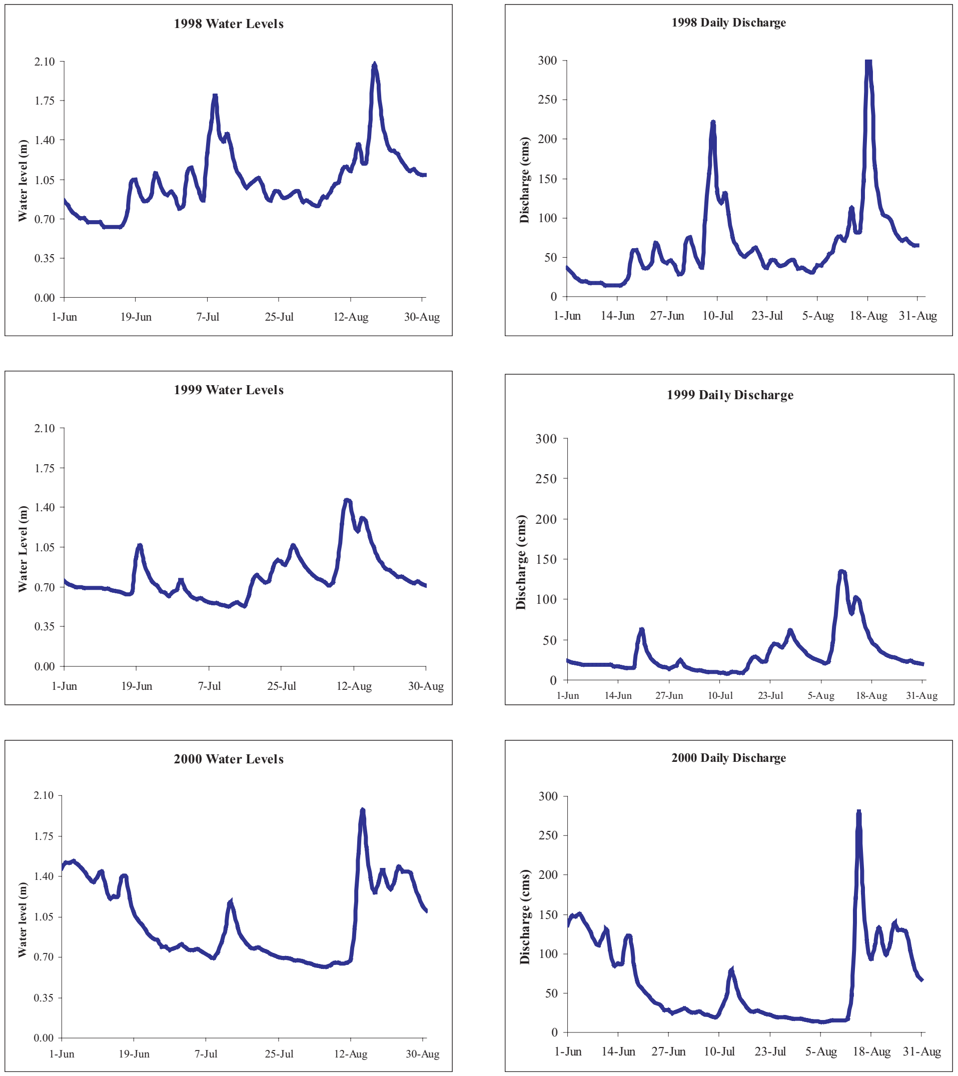


FIGURE 6 Water surface level and mean daily discharge at the Beaver Creek weir, 1998 through 2000.

and Kostohrys, 1998). The weir could not be operated effectively during high water periods, making it impractical to collect data late in the season. This probably resulted in missing part of the summer chum salmon run and any fall chum salmon run that might have occurred in 1999 and 2000. We believe the weir would have provided more information at a site with lower current velocity. There is a site approximately 2 km downstream that might provide better high water conditions for the weir. We believe it would be a good investment to monitor or model expected current velocities prior to choosing a new weir site.

Although the trap had an upstream door, when we opened this to allow fish to swim out, the fish would often wash back onto the weir. We would then recover and carry the fish upstream to slower water. This process caused extra stress, so we stopped using the door. When possible, we recommend the trap be placed in such a way that fish can swim through the upstream door into water where it would be easy to maintain position in the stream.

The pickets were cut up to lower the cost of removing the weir from the field, but the panels can be re-constructed to any desired length by replacing the pickets since all the other panel components were salvaged. The pickets had probably reached the end of their useful life due to brittleness, which we believe was caused by exposure to sunlight and extreme cold. It would be advisable to plan on replacing pickets at intervals of 4 to 5 years if this or similar weirs are used in the future. The cable that anchored the weir is still in the stream, and should be removed in the summer of 2002. At this writing, the weir components (exclusive of pickets) are available for use of other projects on Beaver Creek or elsewhere.

### 5.2 Salmon

In 1999 and 2000, numbers of chinook and chum salmon declined from previous summers. This continued the trend initially described in 1997 (Collin and Kostohrys, 1998). Chum salmon numbers counted through the weir declined more rapidly between 1997 and 2000 than chinook salmon numbers. The skewed sex ratios may suggest the end of the run, characteristically dominated by females, was missed, however there is not a strong pattern of later arrivals by females shown in the data we collected.

There were problems with our method of scale collection and subsequent processing, as shown by the poor ratio of successfully aged scales to samples taken. With the chinook salmon, it appeared the results would have been better had we removed the scales from the envelopes in camp and then cleaned them carefully prior to mounting on gummed cards. This method of transferring scales from envelopes to cards is currently providing the most consistent results for salmon scale sampling projects in Alaska (Price, 2002). We could also have improved the results for chinook salmon by processing the scales promptly after they were returned to Fairbanks. In the case of the 11 chum salmon scale samples, these were simply lost after they came back to the office from the field, indicating a need for better filing.

We know of at least 4 jet boats owned and operated on Beaver Creek by private property owners in the National Recreation Area. Subsistence regulations have changed recently, and increased fishing pressure may thus occur near the mouth of Beaver Creek. Recreational use is increasing on Beaver Creek. The military have used the river for survival training, and sometimes land helicopters on gravel bars and go fishing. With such a small number of female salmon available for spawning above the weir, managers need to know if human activities such as subsistence, sport fishing, or boating are affecting salmon spawning aggregations within the National Recreation Area. To answer questions like this, it will be necessary to go beyond the current study to look at spawning and rearing habitats, and to identify current and potential patterns of human activity affecting fish stocks.

The Bureau of Land Management should build on this project. While it is unrealistic to monitor all the salmon stocks within the Yukon River basin, monitoring spawning aggregations at strategic locations within the basin could provide a good indication of the overall health of salmon stocks. The Beaver Creek weir project has been a component of this monitoring strategy, providing stock status information on one of the smaller chinook and chum populations in the upper basin. Small stocks can be sensitive to overharvest and environmental factors. It is important to monitor these stocks as a long-term commitment and to try to understand natural fluctuations within the population. A summary report should be prepared to put the data from the Beaver Creek weir in a larger context, both spatially and temporally, and to attempt to explain the observations made during the operation of the weir.

### 5.3 Hydrology

The contrast in streamflow for the three years was extreme (Figure 6). The streamflow and corresponding water levels for 1999 were about a third of that of 1998 and 80% of 2000 for the month of July, when the majority of salmon were counted, and also significantly lower than the 13-year average (Table 2) for the stream gage above Victoria Creek (Kostohrys et al., In preparation). The period of increasing streamflow in mid to late July in both 1999 and 2000 may correlate to the timing of the salmon runs, as the peak migration both years followed periods of relative higher water.

## 6 Acknowledgments

We want to express particular gratitude to Gerry Wyse, Eric Yeager, Collin Cogley, Tim DuPont, Randy Goodwin, Chuck Joy, Nora Kelly, Jim Herriges, Mike Bradley, Shane Phillips, Bighead Smiley, and Brandon Peterson, who all helped construct, maintain, install, operate, and remove the weir and camp. The U.S. Fish and Wildlife Service Fisheries Resource Office in Fairbanks, Alaska, provided technical assistance that made the project possible.

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## Appendix A.
## Daily and cumulative counts

TABLE A.1 Daily and cumulative counts of salmon passing through the Beaver Creek weir, 1999 and 2000

| | 1999 | | | | 2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Chinook salmon | | Chum salmon | | Chinook salmon | | Chum Salmon | |
| Date | Daily | Cum. | Daily | Cum. | Daily | Cum. | Daily | Cum. |
| Jul 03 | no data | no data | no data | no data | 0 | 0 | 0 | 0 |
| Jul 04 | no data | no data | no data | no data | 0 | 0 | 0 | 0 |
| Jul 05 | no data | no data | no data | no data | 0 | 0 | 0 | 0 |
| Jul 06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jul 07 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jul 08 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jul 09 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jul 10 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 |
| Jul 11 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 |
| Jul 12 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| Jul 13 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| Jul 14 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| Jul 15 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| Jul 16 | 0 | 0 | 0 | 0 | 2 | 6 | 0 | 0 |
| Jul 17 | 0 | 0 | 0 | 0 | 7 | 13 | 0 | 0 |
| Jul 18 | 0 | 0 | 0 | 0 | 6 | 19 | 0 | 0 |
| Jul 19 | 0 | 0 | 0 | 0 | 14 | 33 | 0 | 0 |
| Jul 20 | 0 | 0 | 0 | 0 | 11 | 44 | 0 | 0 |
| Jul 21 | 0 | 0 | 0 | 0 | 12 | 56 | 0 | 0 |
| Jul 22 | 0 | 0 | 0 | 0 | 14 | 70 | 0 | 0 |
| Jul 23 | 0 | 0 | 0 | 0 | 14 | 84 | 1 | 1 |
| Jul 24 | 12 | 12 | 0 | 0 | 5 | 89 | 2 | 3 |
| Jul 25 | 16 | 28 | 1 | 1 | 2 | 91 | 0 | 3 |
| Jul 26 | 7 | 35 | 0 | 1 | 4 | 95 | 1 | 4 |
| Jul 27 | 25 | 60 | 1 | 2 | 1 | 96 | 0 | 4 |
| Jul 28 | 7 | 67 | 2 | 4 | 0 | 96 | 0 | 4 |
| Jul 29 | 0 | 67 | 3 | 7 | 2 | 98 | 0 | 4 |
| Jul 30 | 7 | 74 | 3 | 10 | 0 | 98 | 1 | 5 |
| Jul 31 | 10 | 84 | 11 | 21 | 2 | 100 | 0 | 5 |
| Aug 01 | 2 | 86 | 10 | 31 | 2 | 102 | 0 | 5 |
| Aug 02 | 14 | 100 | 9 | 40 | 2 | 104 | 0 | 5 |
| Aug 03 | 4 | 104 | 10 | 50 | 1 | 105 | 0 | 5 |
| Aug 04 | 4 | 108 | 6 | 56 | 2 | 107 | 2 | 7 |
| Aug 05 | 6 | 114 | 8 | 64 | 0 | 107 | 2 | 9 |
| Aug 06 | 3 | 117 | 1 | 65 | 3 | 110 | 0 | 9 |
| Aug 07 | 8 | 125 | 0 | 65 | 0 | 110 | 0 | 9 |
| Aug 08 | 3 | 128 | 10 | 75 | 0 | 110 | 0 | 9 |
| Aug 09 | no data | no data | no data | no data | 3 | 113 | 0 | 9 |
| Aug 10 | no data | no data | no data | no data | 1 | 114 | 0 | 9 |

*Table continues on next page...*

TABLE A.1 1999 and 2000 salmon counts, continued

| | 1999 | | | | 2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | **Chinook salmon** | | **Chum salmon** | | **Chinook salmon** | | **Chum Salmon** | |
| **Date** | **Daily** | **Cum.** | **Daily** | **Cum.** | **Daily** | **Cum.** | **Daily** | **Cum.** |
| Aug 11 | no data | no data | no data | no data | 0 | 114 | 0 | 9 |
| Aug 12 | no data | no data | no data | no data | 0 | 114 | 0 | 9 |
| Aug 13 | no data | no data | no data | no data | 0 | 114 | 2 | 11 |
| Aug 14 | no data | no data | no data | no data | 0 | 114 | 0 | 11 |

## Appendix B.
## Mean daily discharges

TABLE B.1 Mean daily discharge ($m^3/s$) and summaries for Beaver Creek at the weir, 1998. Discharges shown in *italics* are estimated from the stream gage above Victoria Creek.

| **Date** | **Discharge** | **Date** | **Discharge** | **Date** | **Discharge** |
|---|---:|---|---:|---|---:|
| 1-Jun | *37* | 1-Jul | 31 | 1-Aug | *37* |
| 2-Jun | *31* | 2-Jul | 69 | 2-Aug | *34* |
| 3-Jun | *25* | 3-Jul | 75 | 3-Aug | *31* |
| 4-Jun | *23* | 4-Jul | 59 | 4-Aug | *31* |
| 5-Jun | *20* | 5-Jul | 45 | 5-Aug | *40* |
| 6-Jun | *20* | 6-Jul | 38 | 6-Aug | *40* |
| 7-Jun | *17* | 7-Jul | 99 | 7-Aug | *45* |
| 8-Jun | *17* | 8-Jul | 158 | 8-Aug | *54* |
| 9-Jun | *17* | 9-Jul | 222 | 9-Aug | *57* |
| 10-Jun | *17* | 10-Jul | 132 | 10-Aug | *74* |
| 11-Jun | *14* | 11-Jul | 119 | 11-Aug | *76* |
| 12-Jun | *14* | 12-Jul | 132 | 12-Aug | *71* |
| 13-Jun | *14* | 13-Jul | 106 | 13-Aug | *88* |
| 14-Jun | *14* | 14-Jul | *76* | 14-Aug | *113* |
| 15-Jun | *14* | 15-Jul | *65* | 15-Aug | *82* |
| 16-Jun | *17* | 16-Jul | 55 | 16-Aug | *82* |
| 17-Jun | *25* | 17-Jul | 50 | 17-Aug | *147* |
| 18-Jun | *57* | 18-Jul | 54 | 18-Aug | *312* |
| 19-Jun | *59* | 19-Jul | 58 | 19-Aug | *266* |
| 20-Jun | *45* | 20-Jul | 62 | 20-Aug | *164* |
| 21-Jun | *37* | 21-Jul | *53* | 21-Aug | *125* |
| 22-Jun | *37* | 22-Jul | *40* | 22-Aug | *105* |
| 23-Jun | *42* | 23-Jul | *37* | 23-Aug | *102* |
| 24-Jun | *68* | 24-Jul | *45* | 24-Aug | *96* |
| 25-Jun | *57* | 25-Jul | *45* | 25-Aug | *85* |
| 26-Jun | *45* | 26-Jul | *40* | 26-Aug | *76* |
| 27-Jun | *42* | 27-Jul | *40* | 27-Aug | *71* |
| 28-Jun | *45* | 28-Jul | *42* | 28-Aug | *74* |
| 29-Jun | *40* | 29-Jul | *45* | 29-Aug | *68* |
| 30-Jun | *28* | 30-Jul | *45* | 30-Aug | *65* |
| | | 31-Jul | 36 | 31-Aug | *65* |
| Monthly summaries: | | | | | |
| June | | July | | August | |
| Max. | 68 | Max. | 222 | Max. | 312 |
| Min. | 14 | Min. | 31 | Min. | 31 |
| Mean | 31 | Mean | 70 | Mean | 90 |

TABLE B.2 Mean daily discharge ($m^3/s$) and summaries for Beaver Creek at the weir, 1999. Discharges shown in *italics* are estimated from the gage above Victoria Creek.

| **Date** | **Discharge** | **Date** | **Discharge** | **Date** | **Discharge** |
|---|---|---|---|---|---|
| 1-Jun | *24* | 1-Jul | 18 | 1-Aug | 35 |
| 2-Jun | *22* | 2-Jul | 15 | 2-Aug | 30 |
| 3-Jun | *20* | 3-Jul | 13 | 3-Aug | 26 |
| 4-Jun | *20* | 4-Jul | 12 | 4-Aug | 25 |
| 5-Jun | *19* | 5-Jul | 12 | 5-Aug | 23 |
| 6-Jun | *19* | 6-Jul | 11 | 6-Aug | 20 |
| 7-Jun | *19* | 7-Jul | 10 | 7-Aug | 23 |
| 8-Jun | *19* | 8-Jul | 10 | 8-Aug | 45 |
| 9-Jun | *19* | 9-Jul | 10 | 9-Aug | 91 |
| 10-Jun | *19* | 10-Jul | 9.3 | 10-Aug | 134 |
| 11-Jun | *18* | 11-Jul | 8.8 | 11-Aug | *133* |
| 12-Jun | *18* | 12-Jul | 8.4 | 12-Aug | *96* |
| 13-Jun | *17* | 13-Jul | *9.5* | 13-Aug | *82* |
| 14-Jun | *17* | 14-Jul | *10* | 14-Aug | *102* |
| 15-Jun | *16* | 15-Jul | *9.1* | 15-Aug | *96* |
| 16-Jun | *15* | 16-Jul | *8.8* | 16-Aug | *74* |
| 17-Jun | *15* | 17-Jul | *14* | 17-Aug | *59* |
| 18-Jun | *16* | 18-Jul | *25* | 18-Aug | *48* |
| 19-Jun | *48* | 19-Jul | *29* | 19-Aug | *42* |
| 20-Jun | *62* | 20-Jul | 26 | 20-Aug | *37* |
| 21-Jun | *42* | 21-Jul | 23 | 21-Aug | *34* |
| 22-Jun | *31* | 22-Jul | 24 | 22-Aug | *31* |
| 23-Jun | 24 | 23-Jul | 38 | 23-Aug | *28* |
| 24-Jun | 20 | 24-Jul | 45 | 24-Aug | *28* |
| 25-Jun | 17 | 25-Jul | 43 | 25-Aug | 26 |
| 26-Jun | 15 | 26-Jul | 41 | 26-Aug | 24 |
| 27-Jun | 14 | 27-Jul | 48 | 27-Aug | 23 |
| 28-Jun | 16 | 28-Jul | 62 | 28-Aug | *24* |
| 29-Jun | 18 | 29-Jul | 54 | 29-Aug | *22* |
| 30-Jun | 25 | 30-Jul | 45 | 30-Aug | *21* |
| | | 31-Jul | 39 | 31-Aug | *20* |
| Monthly summaries: | | | | | |
| June | | July | | August | |
| Max. | 62 | Max. | 62 | Max. | 134 |
| Min. | 14 | Min. | 8.4 | Min. | 20 |
| Mean | 22 | Mean | 24 | Mean | 48 |

TABLE B.3 Mean daily discharge ($m^3/s$) and summaries for Beaver Creek at the weir, 2000. Discharges shown in *italics* are estimated from the gage above Victoria Creek.

| **Date** | **Discharge** | **Date** | **Discharge** | **Date** | **Discharge** |
|---|---|---|---|---|---|
| 1-Jun | *136* | 1-Jul | 30 | 1-Aug | 16 |
| 2-Jun | *147* | 2-Jul | 27 | 2-Aug | 15 |
| 3-Jun | *147* | 3-Jul | 25 | 3-Aug | 14 |
| 4-Jun | *150* | 4-Jul | 25 | 4-Aug | 14 |
| 5-Jun | *144* | 5-Jul | 26 | 5-Aug | 14 |
| 6-Jun | *136* | 6-Jul | 24 | 6-Aug | 14 |
| 7-Jun | *127* | 7-Jul | 22 | 7-Aug | 14 |
| 8-Jun | *116* | 8-Jul | 20 | 8-Aug | 16 |
| 9-Jun | *110* | 9-Jul | 19 | 9-Aug | 16 |
| 10-Jun | *122* | 10-Jul | 24 | 10-Aug | 15 |
| 11-Jun | *130* | 11-Jul | 34 | 11-Aug | 16 |
| 12-Jun | *105* | 12-Jul | 48 | 12-Aug | 18 |
| 13-Jun | *85* | 13-Jul | 78 | 13-Aug | 48 |
| 14-Jun | *88* | 14-Jul | 66 | 14-Aug | 171 |
| 15-Jun | *88* | 15-Jul | 48 | 15-Aug | *280* |
| 16-Jun | *119* | 16-Jul | 38 | 16-Aug | *178* |
| 17-Jun | *122* | 17-Jul | 31 | 17-Aug | *116* |
| 18-Jun | *85* | 18-Jul | 27 | 18-Aug | *93* |
| 19-Jun | *65* | 19-Jul | 26 | 19-Aug | *110* |
| 20-Jun | *57* | 20-Jul | 27 | 20-Aug | *133* |
| 21-Jun | *51* | 21-Jul | 25 | 21-Aug | *110* |
| 22-Jun | *45* | 22-Jul | 24 | 22-Aug | *99* |
| 23-Jun | *40* | 23-Jul | 22 | 23-Aug | *113* |
| 24-Jun | *37* | 24-Jul | 21 | 24-Aug | *139* |
| 25-Jun | *34* | 25-Jul | 20 | 25-Aug | *130* |
| 26-Jun | *28* | 26-Jul | 19 | 26-Aug | *130* |
| 27-Jun | *28* | 27-Jul | 19 | 27-Aug | *127* |
| 28-Jun | 25 | 28-Jul | 18 | 28-Aug | *105* |
| 29-Jun | 26 | 29-Jul | 17 | 29-Aug | *88* |
| 30-Jun | 28 | 30-Jul | 17 | 30-Aug | *74* |
| | | 31-Jul | 17 | 31-Aug | *67* |

| Monthly summaries: | | | | | |
|---|---|---|---|---|---|
| June | | July | | August | |
| Max. | 150 | Max. | 78 | Max. | 280 |
| Min. | 25 | Min. | 17 | Min. | 14 |
| Mean | 87 | Mean | 29 | Mean | 80 |